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Wearable Current Sensing Technology for Electrical Injuries Prevention: Development and Application

Joseph Jr. T. Miomio, Jude Anthony A. Perez, Dariel B. Madis, Yunishalyn Mae S. Udtohan, James Lee F. Lumakang, Mark Anthony Ocampo, Michael James Mataksi, Andre Lue Mindaña

Tagum National Trade School, Apokon, Tagum City, Davao del Norte, Philippines

***Corresponding Author**

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ABSTRACT

Electrical injuries remain a significant occupational hazard, particularly among construction workers, electricians, and technical-vocational trainees in the Philippines. Despite existing safety protocols, many workplaces lack affordable and real-time electrical hazard detection systems. This study aimed to design, develop, and evaluate a wearable current sensing technology capable of detecting electrical current exposure and providing immediate alerts to prevent electrical injuries. The results show that the mean values of the indicators range from 4.05 to 4.38, which are numerically interpreted as "High" to "Very High." These results indicate that the respondents positively evaluated the wearable device in terms of its ability to detect electrical current exposure in real time. The overall mean of the table falls within the "High" interpretation, suggesting that the respondents generally perceive the wearable current sensing technology as accurate, reliable, and effective for electrical injury prevention. In addition, the standard deviation values range from 0.81 to 1.08, which are considered low, indicating that the responses are closely clustered around the mean.

Keywords: wearable technology, electrical hazard detection, current sensing device, electrical safety, occupational safety, electrical injury prevention, real-time monitoring, construction workers, technical-vocational training.

INTRODUCTION

Electrical injuries remain a persistent hazard in both domestic and industrial settings worldwide. In the United States, contact with electricity accounted for 5.6 % of workplace fatalities between 2011 and 2023, with a significant share occurring in non-electrical trades such as construction and maintenance (Electrical Safety Foundation International [ESFI], 2025). Wearable sensor technologies such as smart textiles and polymer-based sensors have advanced rapidly between 2020 and 2023, enabling continuous physiological and environmental monitoring (Harito et al., 2020). In developing countries, the situation is worsened by inadequate enforcement of safety standards, aging infrastructure, and the prevalence of informal labor practices, leaving many workers vulnerable to preventable hazards (World Health Organization [WHO], 2021).

In the Philippines, a review of occupational electrical burn cases at Philippine General Hospital (PGH) in 2021 found that 56.23% of patients stayed in the hospital for treatment, and high-voltage burns accounted for 85% of admissions, with severe burns comprising 41% of cases (Salehi et al., 2021). The primary cause of injury was accidental contact with overhead power lines and falls from heights often led to associated traumatic injuries. According to the Philippine Statistics Authority, occupational injuries with workdays lost dropped from ~17,762 cases in 2019 to 12,076 in 2021; electrical current exposure accounted for approximately 1.5 % of those injuries in 2019 (Philippine Statistics Authority [PSA], 2022).

In Cebu City, a lineman suffered third-degree electrical burns and head trauma after contacting a live secondary wire, due to lack of proper personal protective equipment and safety procedures (Abatayo, 2023). Informal and underregulated work environments remain particularly vulnerable red line installations and neglected safety enforcement continue to cause injuries (Reddit PH reports, 2025).

In Tagum City, the City Government of Tagum (2023) reported that rapid urbanization and infrastructure growth have heightened the risks of electrical hazards, particularly in construction. Many of these incidents are associated with faulty wiring, unsafe electrical practices, and the absence of real-time hazard detection systems.

Despite increasing awareness of workplace electrical hazards, affordable real-time wearable monitoring tools remain scarce, with most existing devices unsuited for continuous use or low-resource environments. From 2020 to 2023, wearable technology research focused mainly on biological and proximity sensing, leaving electrical current detection largely overlooked (Dagdeviren et al., 2020; Harito et al., 2020). This study addresses that gap by developing a low-cost, ergonomically designed wearable current-sensing device for Filipino workers in high-risk sectors such as construction, electrical maintenance, and the informal economy. The device will use smart sensor materials to monitor hazardous current exposure continuously and issue real-time alerts, aiming to improve safety, prevent severe injuries, and advance both occupational safety engineering and public health in the Global South.

The study on wearable current sensing technologies aims to develop and addresses the growing need for real-time, affordable, and user-friendly safety solutions to prevent electrical injuries, which remain a global and national concern, especially among construction and electrical workers in the Philippines (Department of Labor and Employment [DOLE], 2022; Philippine Statistics Authority [PSA], 2022). Existing tools often lack wearability and accessibility, creating a critical gap in safety technologies for low resource settings (Harito et al., 2020; Kim et al., 2021).

By developing a wearable current sensing device, this research contributes practical and innovative solutions to occupational safety, aligning with current trends in smart protective equipment and public health advancement. It holds social value by empowering vulnerable workers, potentially influencing industry practices and labor policies, and promoting safer working environments. The study will be disseminated through academic journals, local government partnerships, and open-source platforms to ensure widespread impact and advocacy for improved electrical safety standards.

Purpose and Description

This study aimed to develop and evaluate a wearable current sensing technology designed to prevent electrical injuries, particularly in construction and related high-risk industries. The purpose was to provide an innovative, low-cost, and locally adaptable solution that addressed the lack of real-time hazard detection in developing contexts. The research sought not only to improve existing safety practices but also to incorporate advanced sensing and alert systems that enhanced worker protection and efficiency.

The project involves designing and prototyping the wearable device, testing its feasibility and performance, and assessing its potential for local application and scalability. Furthermore, the study documents the entire development process, including challenges, lessons learned, and opportunities for refinement, thereby contributing valuable insights to the field of occupational safety and wearable technology.

Objectives of the Study

The study aimed to develop wearable current sensing technologies that detect electrical exposure and provide timely alerts to reduce electric injuries and improve personal safety.

Specifically, it sought to achieve the following specific objectives:

To design and develop a wearable device capable of detecting current electrical exposure in real time.

To Assess the level of acceptability of the product in terms of:

1.1. Accuracy;
1.2. Responsivenes;
1.3. Safety in simulated environments;
1.4. Usability; and
1.5. Comfort.

Significance of the Study

This study holds substantial social value as it aims to address one of the most pressing safety concerns in both educational and professional settings electrical hazards. The development and integration of a wearable current sensing device can provide not only an innovative solution to improve safety but also a cost-effective and accessible approach that can be implemented in resource-limited environments. By highlighting the practical application of science, engineering, and safety awareness, the study may support the creation of a more proactive and responsive culture toward occupational and personal safety.

Students. Particularly those enrolled in technical vocational and electrical-related strands. It introduces them to real-world innovations and offers opportunities for hands-on learning, critical thinking, and awareness of modern safety practices. Through the device, students gain experiential knowledge of wearable technologies, current detection, and hazard prevention, thereby enhancing their future employability and safety consciousness.

Electricians. The study offers a vital layer of protection by providing real-time alerts against potential hazards in their working environment. The wearable device enhances situational awareness, minimizes risk exposure, and promotes adherence to safety practices, thereby reducing occupational accidents.

Teachers. Especially those in technical and vocational subjects, can use the device as a teaching tool to demonstrate real-life applications of scientific and engineering principles. The device enables teachers to bridge theoretical concepts with practical implementation, thereby improving classroom engagement and learning outcomes.

School administration. This study is significant as it promotes a safer learning environment by introducing wearable current sensing technologies that help prevent electrical hazards within school facilities. It also provides administrators with practical insights for adopting cost-effective safety measures.

Parents. Benefit indirectly from this study through the increased safety of their children, especially those studying or working in environments exposed to electrical risks. Knowing that preventive technologies are being explored and applied within the academic community provides parents with reassurance regarding the well-being and preparedness of their children.

Future researchers. Can build upon the findings and methodology of this study to create more advanced versions of wearable safety technologies. It opens avenues for interdisciplinary collaboration in fields such as electronics, materials science, education, and occupational health. This foundational study can serve as a benchmark for further exploration in making workplaces and learning environments safer through localized, affordable, and scalable innovation.

Scope and Limitations of the Study

This developmental research aimed to design, develop, test, and apply a wearable current-sensing device to help prevent electrical injuries through real-time detection of current exposure. A low-cost prototype using locally available materials will be created and evaluated for accuracy, responsiveness, safety, and user comfort. The study will be conducted in one of school in the Tagum City during the school year 2025–2026, with the respondents consisting of selected senior high school students enrolled in electrical installation and maintenance (EIM) programs, as well as their instructors. Data will be collected through prototype testing, questionnaires, and direct observation in simulated electrical work tasks.

This study is limited to testing a wearable prototype in simulated, low-voltage environments, excluding high-voltage, real-world conditions, long-term durability assessments, mobile app integration, and industrial-scale deployment. Constraints include the availability of locally sourced materials, laboratory equipment, and financial resources, which may limit the generalizability of findings to larger industrial settings. It assumes participants will follow safety protocols and provide honest feedback. The research also excludes alternative approaches such as software-based monitoring, smart PPE, or AI-integrated systems, focusing solely on developing and initially applying a hardware-based wearable device for individual electrical safety (Kumar et al., 2021).

Definition of Terms

The following terms are defined to provide clarity and consistency in understanding key concepts used in this study and each term is explained in the context of how it is applied within the research.

Wearable Current Sensor Technologies. In this study, this term refers to body-worn devices equipped with current-sensing components designed to detect electrical hazards and provide real-time alerts to the wearer.

Electrical Injuries Prevention. Referring to the process of reducing or avoiding harm caused by electrical current exposure through the use of a wearable current-sensing device. It involves the device’s ability to detect abnormal or hazardous electrical currents in real time and alert the user, thereby minimizing the risk of electric shock, burns, or electrocution during electrical-related tasks.

Development and Application. In this study, this term refers to the creation of a functional wearable current-sensing prototype and its initial testing in simulated environments to evaluate its safety, accuracy, and usability for electrical injury prevention.

MATERIALS AND METHODS

Research Design

This study utilized a structured research design to ensure the systematic development and evaluation of the wearable current-sensing device. The approach combined quantitative methods for measuring performance with a design and development framework that supports prototype creation, testing, and refinement. The study employed a quantitative research approach, which emphasizes objective measurement and statistical analysis of numerical data to test hypotheses and evaluate performance (Creswell & Creswell, 2021). By applying statistical tools, this approach ensures rigor, reliability, and validity in assessing the effectiveness of the prototype.

Furthermore, the study uses a Design and Development Research (DDR) design, which emphasizes the systematic creation and iterative testing of innovative products. DDR is particularly suitable for technology-focused studies as it integrates analysis, design, development, and evaluation to produce functional and user-ready prototypes (Richey & Klein, 2019). Recent studies highlight its effectiveness in wearable technology development, where continuous refinement enhances accuracy, usability, and safety (Liu et al., 2022). This makes DDR appropriate for the present study, as it supports the structured design, testing, and improvement of the wearable current-sensing device.

Research Subjects

The study was conducted in one of the schools in Tagum City, Davao del Norte, among Senior High School students enrolled in the Electrical Installation and Maintenance (EIM) strand. EIM students were the appropriate respondents for this study because their coursework and practical training involve direct hands-on experiences with electrical systems, allowing them to meaningfully evaluate wearable current-sensing devices.

The study used purposive sampling, a non-probability sampling technique in which participants were selected because they possess specific knowledge or experience related to the phenomenon of interest. Purposive sampling was justified in this context because the goal is to gather detailed, context-rich data from individuals directly exposed to electrical risks (Memon et al., 2025).

To determine the sample size, the researcher applied a sample size formula (e.g., Cochran's formula or equivalent) suitable for finite populations, with a confidence level of 95% and a margin of error of 5%. Given an estimated population of 120 EIM Senior High School students in one of the schools in Tagum, the calculation using third-party software indicates a minimum sample size of 92 respondents.

Table 1: Distribution of Research Subjects

Grade Level	Population	Percentage	Sample Size
EIM Grade 11	47	77.05%	42
EIM Grade 12	14	22.95%	11
Total	**61**	**100%**	**53**

Process Model

This study employed a Design and Development Research (DDR) framework to guide the systematic creation of the wearable current-sensing technology. The material lists the essential components, including a rubber wristband, electrical tape, guitar string, 2 1.5V battery, wire, red/green LED light, buzzer, and Hall effect sensor. The framework followed six key phases problem identification, design and planning, prototyping, testing, iterative refinement, and feasibility assessment ensuring that the device is developed, evaluated, and improved in a structured and practical manner to meet safety and usability goals.

Problem Identification and Conceptualization. The first phase involves identifying the high incidence of electrical injuries among workers and trainees in Tagum City. Background information from occupational safety reports, related studies, and user experiences was gathered to define the problem. From this, the concept of a wearable device capable of detecting hazardous electrical exposure in real time is formulated as a potential solution.

Design and Planning. Once the problem is established, a comprehensive design plan is created. This includes setting research objectives, outlining performance indicators (e.g., detection accuracy, response time, usability), and specifying required resources such as microcontrollers, sensors, and fabrication tools. Success criteria, such as comfort, reliability, and safety compliance, are also identified.

Prototyping and Development. A working prototype of the wearable current-sensing device was developed using cost-effective and locally available materials. Circuit designs are prepared, hardware components are assembled, and the enclosure is fabricated. The prototype translates the conceptual idea into a functional device capable of monitoring current exposure.

Testing and Evaluation. The prototype is subjected to rigorous testing under controlled, simulated environments. Instruments such as calibrated current sources, clamp meters, oscilloscopes, and thermal cameras were utilized to assess its accuracy, responsiveness, and safety. Usability and comfort were evaluated through user trials with EIM Senior High School students, using standardized questionnaires and observation checklists.

Iterative Refinement. Based on test data and user feedback, the prototype underwent multiple refinements to improve performance. Identified issues such as sensitivity calibration, comfort adjustments, or alert mechanisms are resolved. This cycle of testing and improvement continues until the device meets predefined standards for accuracy, usability, and safety.

Feasibility Assessment and Implementation. In the final phase, the feasibility of scaling up the device for broader use was assessed. Factors such as production cost, accessibility of materials, sustainability, and potential

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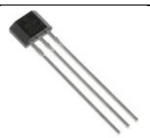
adoption in educational and industrial settings were also evaluated. If found feasible, recommendations for implementation, field deployment, and commercialization pathways were formulated.

Table 2 Materials of Wearable Current Sensing Technology

Figure	Name	Description	Price
	Watch	Use for base of device.	---
	Electrical tape	Use for insulate electrical wires and other materials that conduct electricity.	17.50
	Guitar strings	Use for antenna.	79
	2 1.5 Battery	Use to power the device.	31.72
	Wire	For connection.	37
	Red/Green LED light	Use to produce light efficiently.	19.00
	Buzzer	Use to produce an audible sound or alert in response to an electrical signal.	18
	Hall Affect Sensor.	Use to detect the direction of a magnetic field and convert it into an electrical signal.	25

Total: 227.22

Research Instrument

This study utilized a survey questionnaire as the primary research instrument to assess the accuracy, responsiveness, safety, usability, and comfort of the developed wearable current-sensing device for electrical injury prevention.

The instrument was adapted and modified from several existing standardized tools to fit the study's objectives and local context. Specifically, items were drawn and modified from the *System Usability Scale (SUS)* developed by Brooke (1996), as well as from previous studies on wearable technology, including Hrabovská, Kajáti, and Zolotová (2023), Keogh et al. (2021), and Kwasnicka et al. (2022).

These references collectively guided the development of the questionnaire to ensure comprehensive evaluation of usability, accuracy, and safety aspects of wearable devices (Brooke, 1996). Minor simplifications and wording adjustments were made to ensure that the instrument was contextually relevant, understandable, and culturally appropriate for the respondents.

Table 3 shows the parameter limits for evaluating the materials of the wearable current sensing technology. Ratings from 4.20–5.00 indicate very high or excellent performance, 3.40–4.19 indicate high performance with minor limitations, 2.60–3.39 indicate moderate performance needing improvement, 1.80–2.59 indicate low performance with significant shortcomings, and 1.00–1.79 indicate very low performance, meaning the product is ineffective and requires major redevelopment.

Table 2 Parameter Limits of Materials of Wearable Current Sensing Technology

Range	Description	Interpretation
4.20 – 5.00	Very High	Indicates excellent performance and strong effectiveness; the product is highly functional and applicable.
3.40 – 4.19	High	Reflect good performance with minor limitations; the product is effective and largely usable.
2.60 – 3.39	Moderate	Suggests fair performance; the product works but needs improvement before broader use.
1.80 – 2.59	Low	Poor product shows weak performance; the product has noticeable shortcomings and requires significant enhancement.
1.00 – 1.79	Very Low	Represents very poor performance; the product is ineffective in its current state and needs major redevelopment.

Data Analysis

The data gathered was analyzed and interpreted through mean and standard deviation.

Ethical Considerations

This study strictly adhered to established ethical principles to ensure the protection of participants, integrity of data, and credibility of the research process.

Ethical guidelines such as the *Belmont Report* (1979), the *Declaration of Helsinki* (World Medical Association, 2013), and the *National Ethical Guidelines for Health and Health-Related Research* (Philippines, 2017) serve as the foundation for the following practices; Informed Consent, Privacy and Confidentiality, Beneficence, Respect for Persons, Fair Treatment and Justice, Data Handling and Security, Avoiding Bias, Conflicts of Interest and Transparency, Plagiarism and Research Integrity, Safety Measures, and Reporting Results**.**

RESULTS AND DISCUSSION

Designing and Developing a Wearable Device Capable of Detecting Current

Figure 1 presents the actual sensor of the wearable device. Highlights the arrangement of key components including the antenna, visual indicator (LED), chip circuit board, connectors and audible alert element (buzzer). These parts work together to sense electrical exposure and immediately notify the wearer through both visual and audible signals.

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Figure 1 Sensor of Wearable Current Sensing Technology

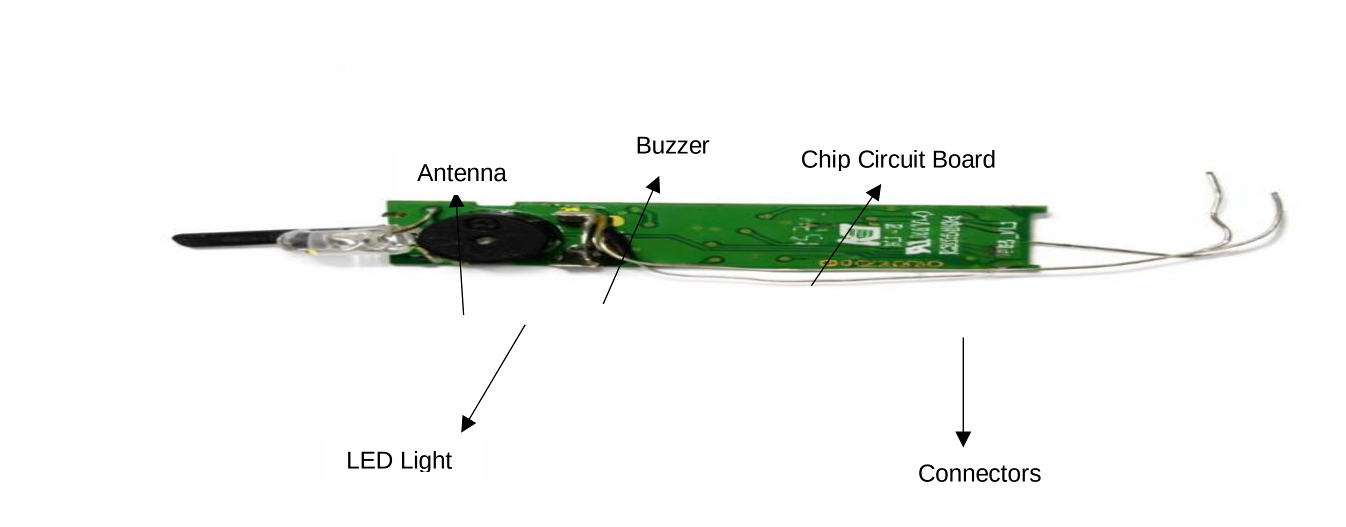

Figure 2 shows battery for supplies power to the device, making it portable and functional even without a direct power source. The power that the battery has is 5V that is enough to supply the device in a long period of time. This power capacity also enables the device to run for a long period of time.

Figure 2 Sensor with Battery

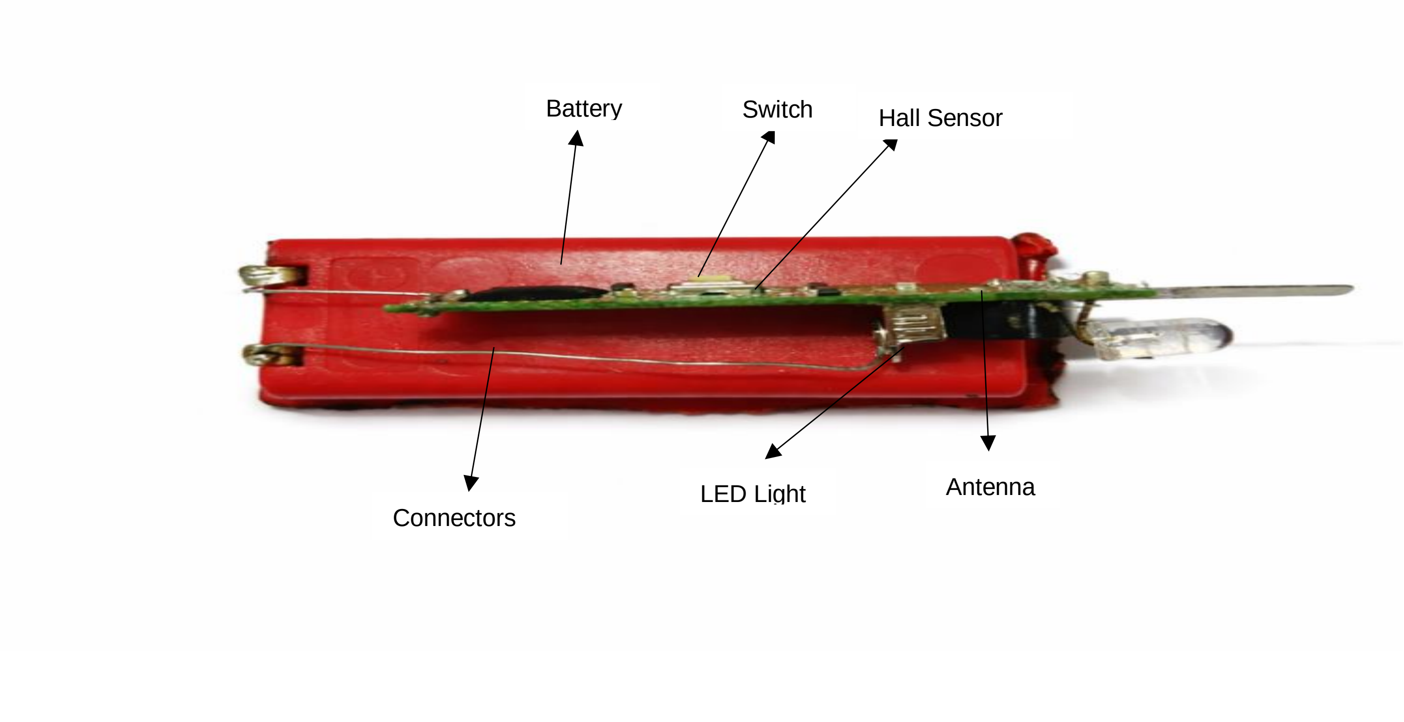

Figure 3 shows a damaged watch. The researcher used the watch as the base for the sensor device to make it function as a current detector. The metallic base of the watch serves as the main base for the sensor. A rubberized wrist band was used as it is more convenient and safer to use compared to a metal strap.

This design helps reduce the risk of unintended electrical conduction while improving user comfort. Additionally, the compact structure of the watch allows the sensor components to be securely mounted without affecting portability.

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Figure 3 Base of the Sensor

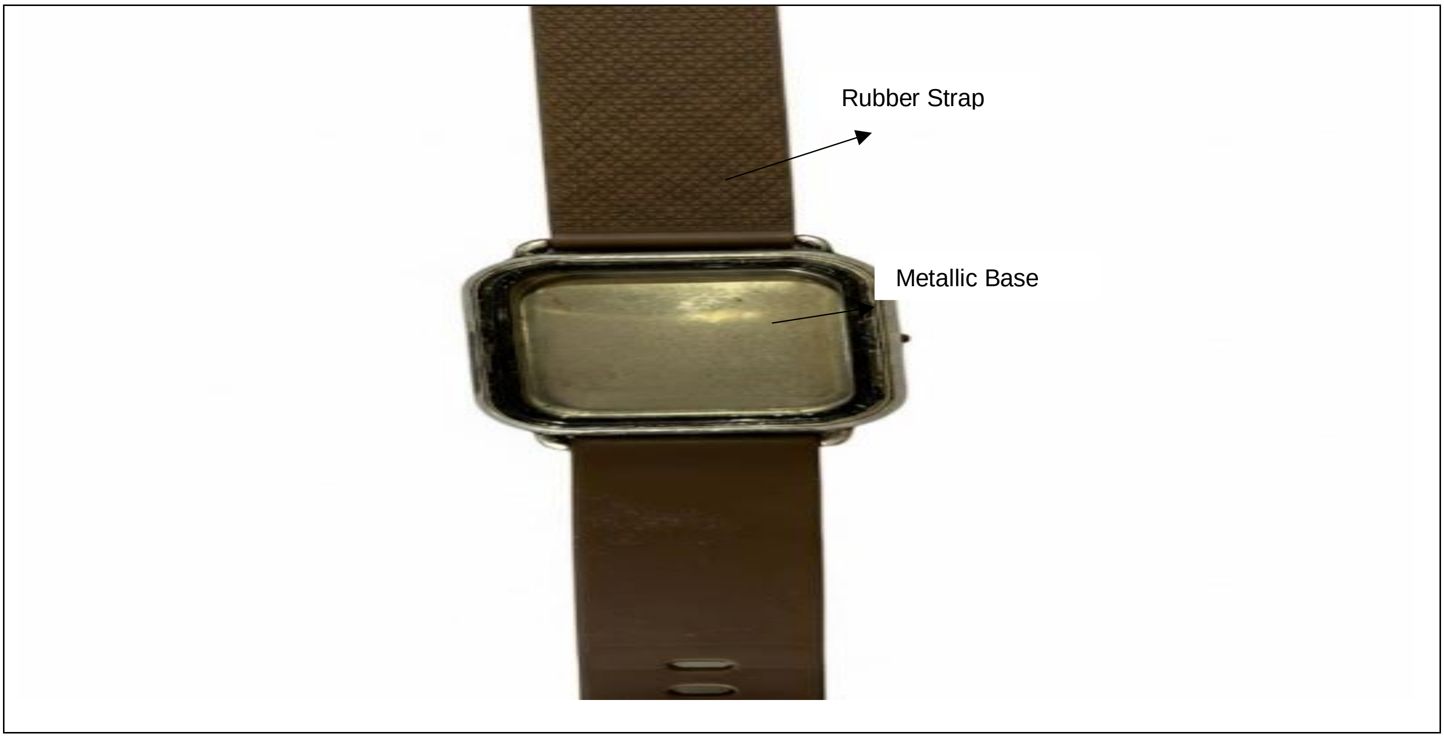


Figure 4 This figure shows the base of the wearable current sensing device, which is designed to be attached securely to the user's hand. The flat plate ensures stable contact with the surface, allowing accurate detection and measurement of electrical current during use. This wearable design enables continuous monitoring while maintaining comfort and reliability for the user. Additionally, the compact structure of the device allows it to be worn for extended periods without causing discomfort. The secure attachment minimizes movement-related errors, improving the consistency of the collected data. Overall, the design supports efficient real-time current monitoring suitable for practical and daily applications.

Figure 13 Base of the Sensor with Plate

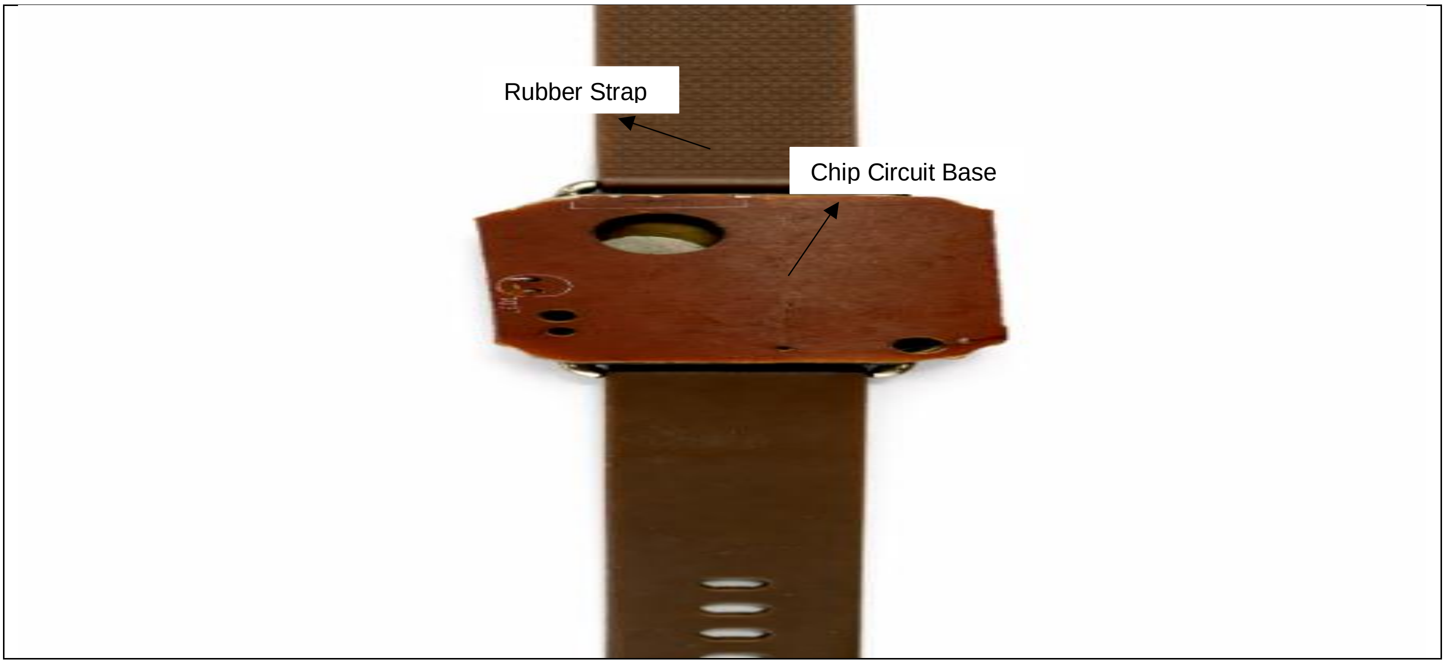


Figure 14 shows the finalized base of the sensor after assembly. Electrical tape was applied to fully cover the base, providing insulation and protecting the components from external damage. This method also improves the durability and stability of the sensor during actual use.

Figure 14 Complete Base of the Sensor

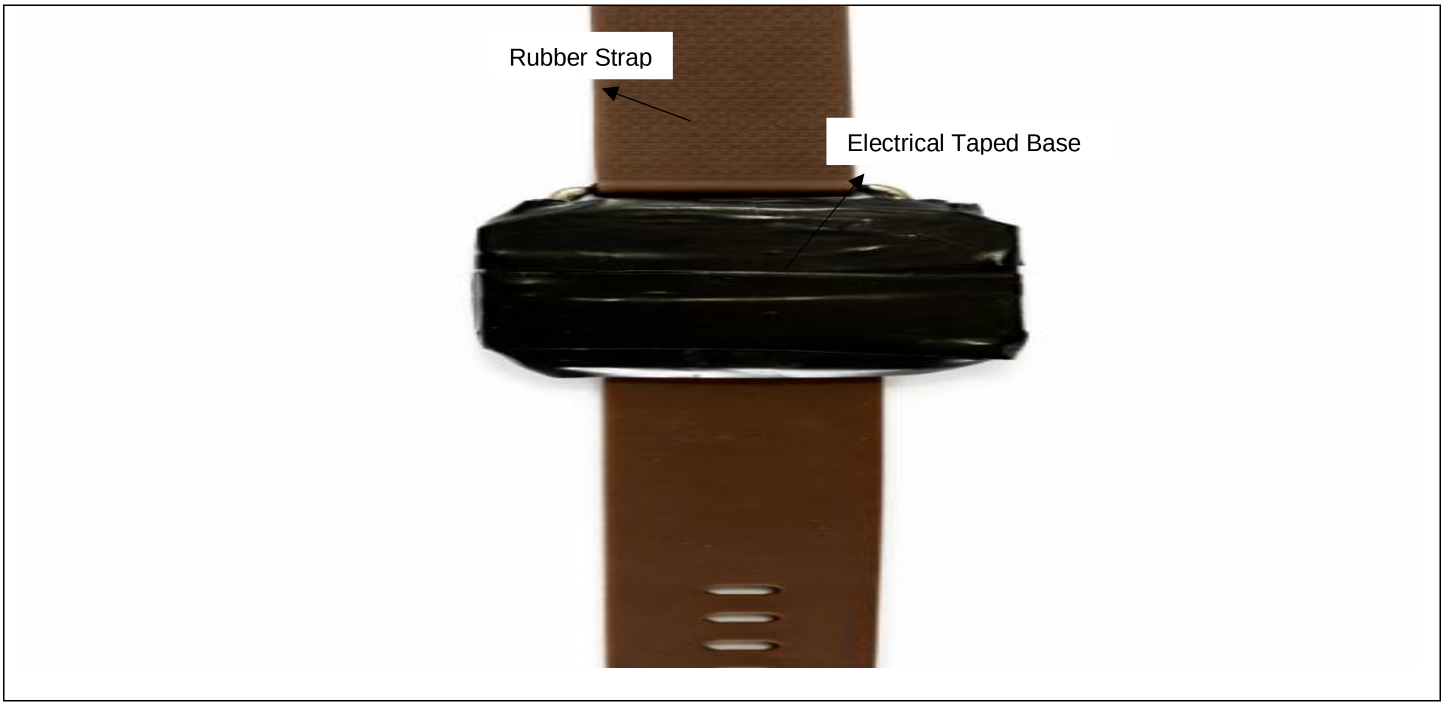


Figure 15 shows the sensor attached to its base, demonstrating how it is positioned before full assembly. The base provides stability and keeps the sensor properly aligned for accurate operation. The image also shows how the sensor will be mounted as part of the wearable system.

Figure 15 Sensor with Base of the Wearable Current Sensing Technology

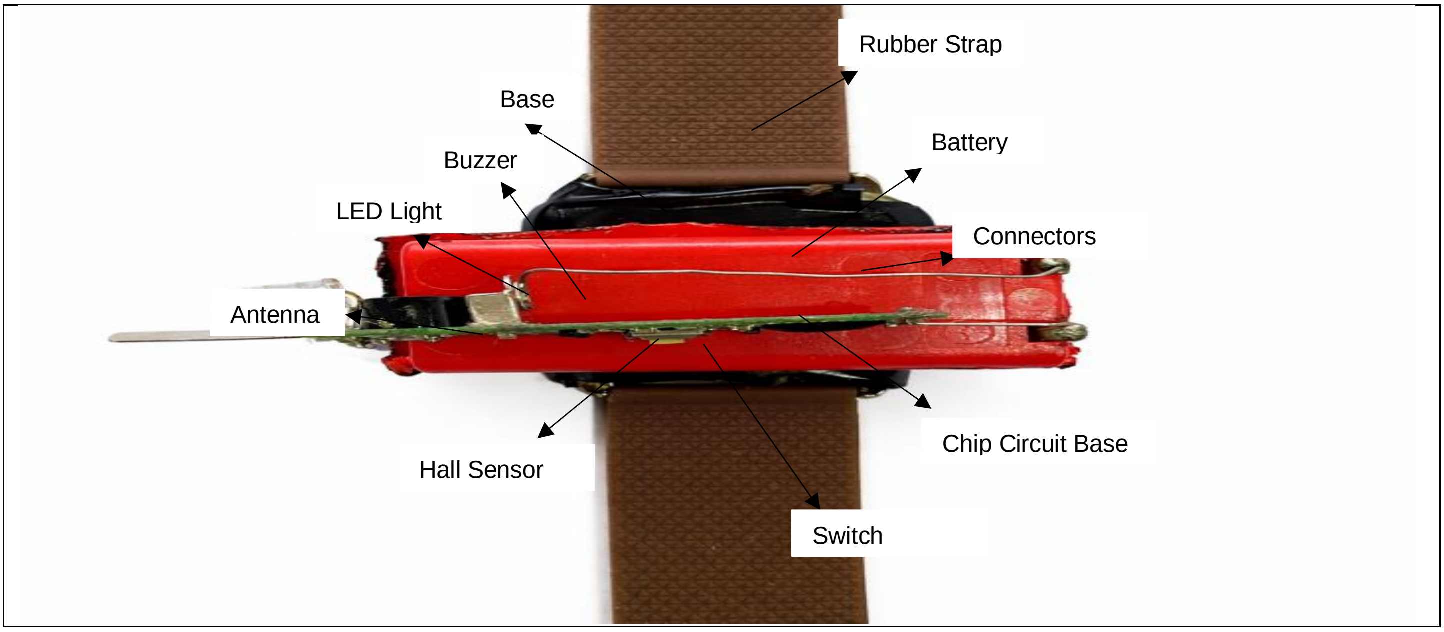


Figure 16 presents the actual wearable current-sensing technology device developed in this study, showing its physical structure, placement, and overall design intended for monitoring electrical current exposure.

The device is designed to be worn by the user, allowing real-time detection of electrical current that may pose a risk of injury. Its compact and wearable form highlights its practicality for everyday use, particularly in environments where electrical hazards are present.

This figure emphasizes how the device integrates current-sensing technology into a wearable format to support electrical injury prevention and enhance user safety.

Figure 16 The Wearable Current Sensing Technology

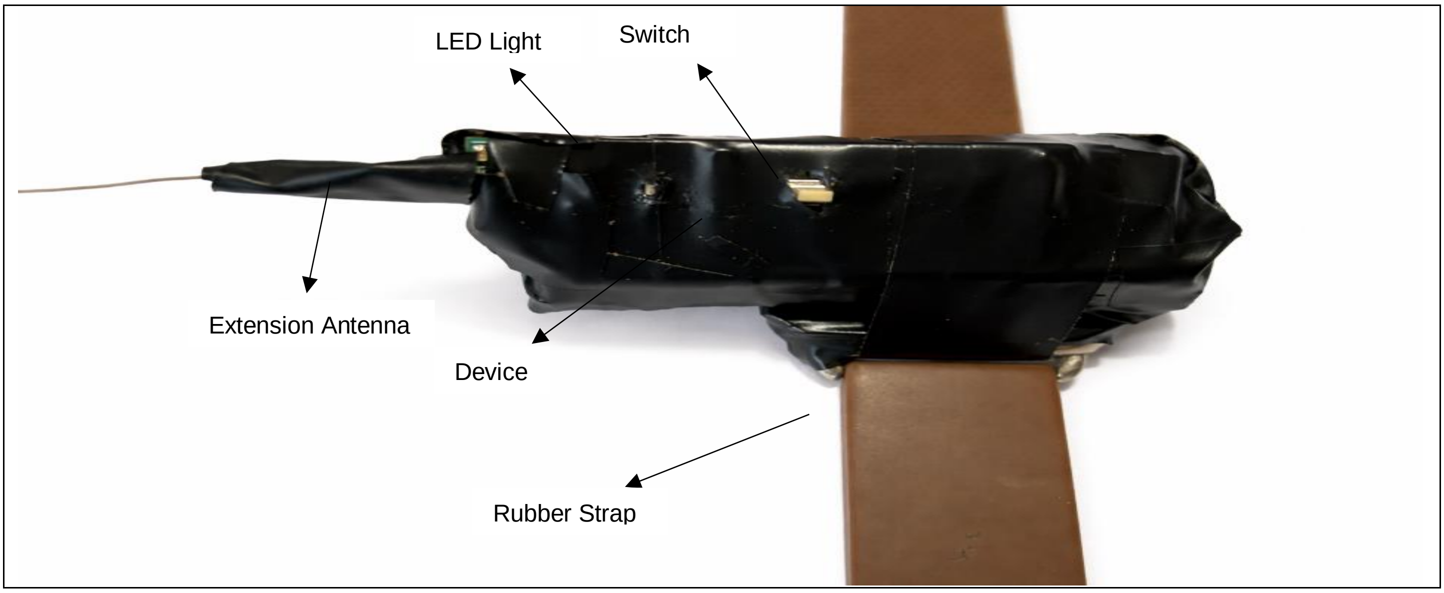
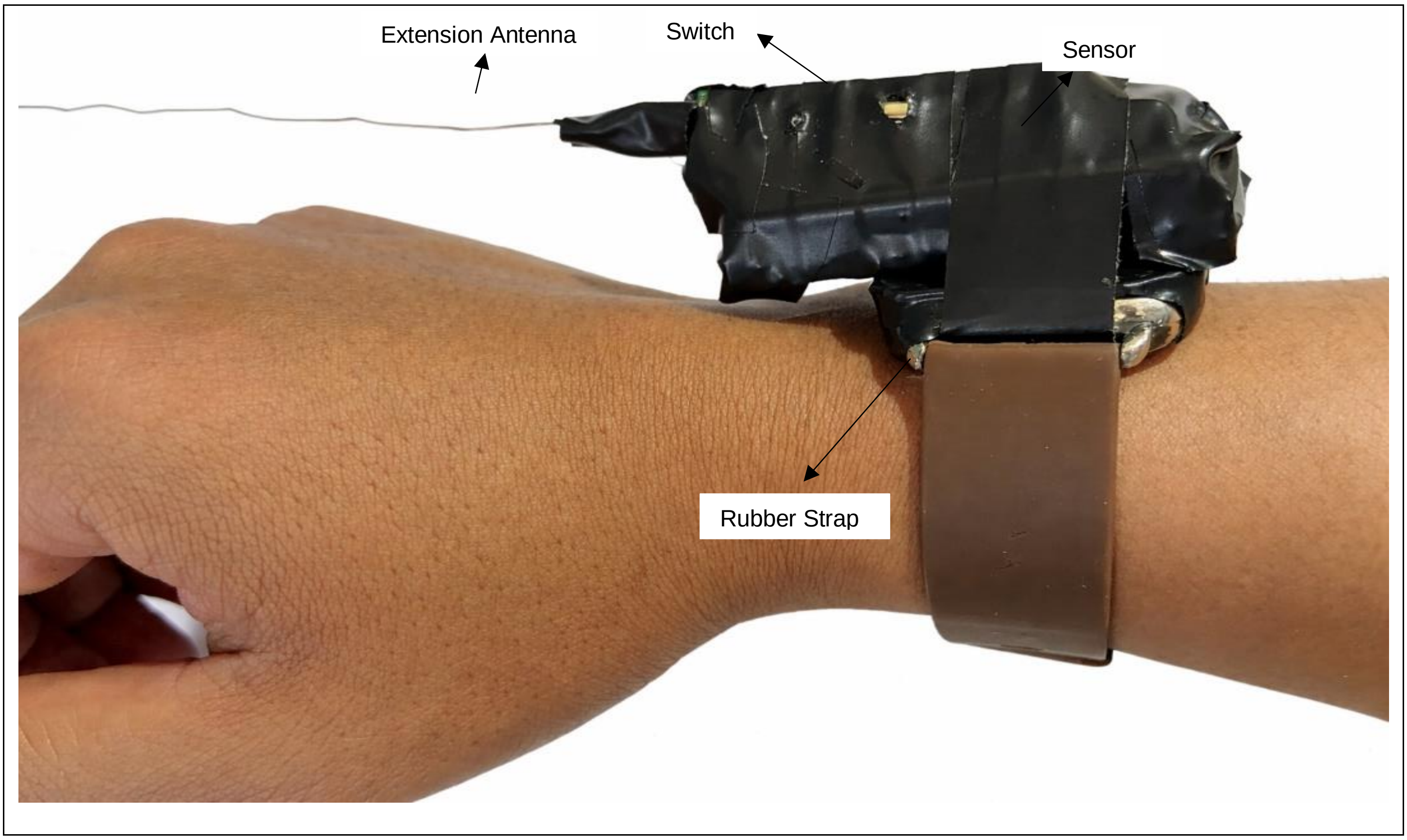


Figure 17 wearable current sensing technology device is designed to detect the presence of electrical current in real time. It is worn on the wrist, allowing continuous monitoring without interfering with the user's normal activities. The device helps improve safety by providing early warning of potentially dangerous electrical exposure. Its compact and lightweight design makes it suitable for daily use in electrical work environments.

Figure 17 Wearing the Wearable Current Sensing Technology



Recent studies on wearable sensor systems and WBANs highlight the importance of multi-sensor integration, real-time processing, low-power communication, and reliable data transmission (El-Adawi et al., 2024). Although primarily designed for health monitoring and rehabilitation, the integration principles of WBANs

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provide a strong framework for other safety-related technologies. In the context of electrical hazard prevention, such features are essential to ensure dependable real-time monitoring, precise current detection, and seamless sensor communication in high-risk environments. In comparison, the present wearable current sensing device applies these WBAN integration principles specifically for electrical hazard detection, promoting safe, stable, and reliable real-time monitoring for worker protection.

Self-powered wearable sensors utilizing energy-harvesting mechanisms, such as triboelectric and piezoelectric technologies, allow for reduced battery dependence, low-power consumption, and continuous long-term operation (Tang & Sun, 2023). While this study did not focus on electrical current sensing, it provides valuable insights for designing energy-efficient wearable sensors. These features are directly applicable to wearable current sensing devices intended for electrical hazard prevention, where uninterrupted functionality is critical for ensuring user safety. In comparison, the present wearable current sensing device incorporates low-power design strategies to maintain continuous and reliable operation during electrical hazard monitoring.

Wearable sensors constructed from advanced materials such as nanomaterials and conductive polymers offer high sensitivity, flexibility, stretchability, and stable signal performance during movement, making them suitable for continuous monitoring applications (Vaghasiya etc., 2023). Although their research focused on telehealth, the insights regarding material selection, sensor sensitivity, and wearability are directly relevant to developing wearable current sensing devices. Incorporating these features ensures that the device can detect electrical currents accurately while remaining comfortable and safe for the wearer. In comparison, the present wearable current sensing device utilizes similar material strategies to ensure accurate current detection while remaining comfortable and safe for the user.

Assessing the Level of Acceptability

Table 4 presents the evaluation of the wearable sensing technology in terms of usability and comfort, showing the mean scores, standard deviations, and interpretations for each indicator. The overall average rating of the device is 3.94 with a standard deviation of 0.92, which is interpreted as high. The highest-rated indicators were “I think the device was easy to use” (Mean = 4.36, Very High) and “I imagine that most people would learn to use this device very quickly” (Mean = 4.25, Very High), while the lowest-rated indicator was “I find the device unnecessarily complex” (Mean = 3.04, Moderate). There is some disparity in the data, as shown by the variation in mean scores and standard deviations, particularly for the indicator on complexity

Table 4 Evaluation of the Wearable Sensing Technology in terms of Usability and Comfort of the Device

Indicators	Mean	SD	Interpretations
1. I think that I would like to use this device frequently.	4.11	0.85	High
2. I think the device was easy to use.	4.36	0.83	Very High
3. I find the device unnecessarily complex.	3.04	1.11	Moderate
4. I feel very confident using the device.	4.13	0.86	High
5. I imagine that most people would learn to use this device very quickly.	4.25	0.90	Very High
6. I feel comfortable wearing the device for an extended period.	3.87	0.90	High
7. I feel no discomfort about the size and weight of the device.	3.74	1.04	High
8. I feel that the device allows enough freedom of movement while performing tasks.	4.06	0.89	High
Average:	**3.94**	**0.92**	**High**

The findings of this study are supported by existing literature, which emphasizes that user acceptance of wearable devices depends not only on performance accuracy but also on comfort, stability, and design. Previous research has highlighted those factors such as fitness, form factor, and non-intrusive placement are critical for sustained use and positive user experiences. This aligns with the results in Table 4, where participants rated the wearable sensing technology highly in terms of usability and comfort (Bruno et al., 2020)

Table 5 presents the evaluation of the wearable sensing technology in terms of safety, showing the mean scores, standard deviations, and interpretations for each indicator. The overall average rating of the device is 4.13 with a standard deviation of 0.92, which is interpreted as high. The highest-rated indicator was “I feel safe using this device in an actual work environment” (Mean = 4.21, Very High), while the lowest-rated indicator was “I feel safe wearing the device during the simulated testing” (Mean = 3.98, High). There is some disparity in the data, as reflected by the variation in mean scores and standard deviations, particularly in perceptions of safety during simulations.

Table 5 Evaluation of the Wearable Sensing Technology in Terms of Safety

S/N	Indicators	Mean	SD	Interpretation
1	I feel that the materials used in the prototype are durable and properly insulated.	4.19	0.81	High
2	I feel safe using this device in an actual work environment.	4.21	0.86	Very High
3	I feel safe wearing device during the simulated testing.	3.98	1.08	High
	Average	4.13	0.92	High

The findings of this study are supported by existing literature, which demonstrates that wearable technologies can enhance worker safety in hazardous environments. Research shows that devices monitoring physiological conditions and environmental hazards help reduce accident risks and improve protection through real-time safety alerts. Additionally, the use of durable materials and integrated sensors increases users' confidence and perceived safety, aligning with the study's results (De Fazio et al., 2022).

Table 6 presents the evaluation of the wearable sensing technology in terms of device responsiveness, showing the mean scores, standard deviations, and interpretations for each indicator. The overall average rating of the device is 4.31 with a standard deviation of 0.84, which is interpreted as very high. The highest-rated indicator was “The device's buzzer activates whenever current is detected, providing an audible alert to the user” (Mean = 4.47, Very High), while the lowest-rated indicator was “The device shows no noticeable lag or delay, maintaining consistent performance during operation” (Mean = 4.21, Very High). There is minimal disparity in the data, as all indicators received very high ratings with relatively small variations in standard deviations.

Table 6 Evaluation of the Wearable Sensing Technology in Terms of Responsiveness of the Device

Indicators	**Mean**	**SD**	**Interpretations**
1. The device responds immediately when electrical current is detected, ensuring rapid hazard recognition.	4.34	**0.94**	Very High
2. The device's response time is suitable for real-time hazard detection, allowing the system to react quickly and effectively.	4.23	**0.95**	Very High
3. The device shows no noticeable lag or delay, maintaining consistent performance during operation.	4.21	**0.77**	Very High
4. The device's buzzer activates whenever current is detected, providing an audible alert to the user.	4.47	**0.70**	Very High
Average:	**4.31**	**0.84**	**Very High**

The findings of this study are supported by existing literature, which highlights the effectiveness of electrical stimuli in producing precise and consistent responses in wearable technologies. Research shows that electro-responsive “smart” materials can change their physical or electrical properties in response to an external electric field, enabling rapid and reliable device performance. This aligns with the study's results, which indicate that the wearable current sensing device promptly detects electrical current and provides immediate feedback to enhance user safety and reduce the risk of electrical injuries (Ahmadi et al., 2023).

We analyzed the responses of 53 participants using the mean and standard deviation. The survey used a 5-point Likert scale, where higher means show stronger agreement.

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The average scores for the items ranged from 4.05 to 4.38, which fall under "High" to "Very High." This means that participants had a positive view of the wearable current sensing device and agreed that it can detect electrical current exposure in real time. The overall average also falls within the "High" range, showing that respondents generally see the technology as accurate, reliable, and effective in preventing electrical injuries.

In addition, the standard deviation values range from 0.81 to 1.08, which are considered low, indicating that the responses are closely clustered around the mean. Discussion The high mean scores, interpreted as "High" to "Very High," imply that the developed wearable current sensing technology successfully meets its design objectives, particularly in detecting electrical current exposure. These findings support the effectiveness of the device as a preventive safety tool in electrically hazardous environments.

Moreover, the low standard deviation values indicate a high level of consistency among the responses of the 53 respondents. This consistency suggests that the participants share similar perceptions regarding the accuracy and functionality of the device. The minimal variation in responses strengthens the reliability of the data and reinforces the credibility of the results. The numerical interpretation of the mean and standard deviation confirms that the wearable current sensing technology is well-accepted and positively evaluated, supporting its development and application as an innovative solution for prevention of electrical injuries.

Research on wearable sensing devices shows they significantly improve worker safety through real-time hazard detection and monitoring. Nnaji and colleagues found that features such as detecting proximity to energized electrical materials are especially critical in construction settings, benefiting both workers and management. Although some workers may have initial privacy concerns, many are willing to share necessary data when clear safety benefits are evident (Nnaji et al., 2021).

The rapid advancement of smart wearable sensing technologies has enhanced real-time monitoring systems in healthcare and safety applications. These devices enable continuous data collection while allowing users to remain mobile and active. Recent innovations highlight the importance of wearable sensors in preventive and point-of-care settings. Such developments support the creation of wearable current sensing technology designed to detect electrical exposure in real time, contributing to the prevention of electrical injuries and improving overall safety (Mondal et al., 2020).

Wearable IoT technologies with integrated current sensors and risk assessment algorithms have been developed to detect and prevent electrical shock hazards in real time. By combining sensor-based monitoring and wireless communication, these systems provide early warnings when dangerous electrical conditions are detected. Such advancements support the development of wearable current sensing technology for effective electrical injury prevention (Xie et al., 2019).

Recent research highlights the importance of wearable technological devices in improving workplace health and safety, particularly in high-risk industries. Wearable technologies equipped with advanced sensors and data-processing capabilities help monitor workers' conditions and reduce the likelihood of accidents. These devices contribute to minimizing hazards, preventing injuries, and enhancing overall industrial productivity. The study prioritizes sectors such as construction, mining, agriculture, textile, and chemistry—industries where labor-intensive tasks increase the risk of fatigue, injury, and accidents. Using multi-criteria decision-making methods, the research emphasizes that expanding the adoption of wearable devices can significantly strengthen occupational safety management. These findings support the development and application of wearable current sensing technology as an effective tool for preventing electrical injuries and improving workplace safety in high-risk environments (Aksüt et al. 2024).

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary of Findings

The device developed in this project is a wearable electrical current sensing unit designed to detect unsafe levels of exposure in real time and to provide timely alerts to the user to prevent electrical injuries. The system integrates a Hall effect current sensor for accurate detection of current flow, a microcontroller for signal processing, and both visual and auditory alert mechanisms, including red and green LEDs and a buzzer, to effectively notify the wearer of hazardous conditions. To ensure portability and user comfort, the sensing circuitry and alert components are housed on a wearable base device, powered by two 1.5 V batteries with secure electrical connections insulated using electrical tape and wire. The conceptual design emphasizes safety, comfort, and functionality, meeting the core requirements of continuous monitoring and immediate alert response within a compact and ergonomic form factor. This project was developed over the course of the 2025–2026 school year, with final design implementation and evaluation completed by the end of the academic period.

The results showed that the developed product has a high level of acceptability in terms of accuracy, responsiveness, safety in simulated environments, usability, and comfort. The product demonstrated reliable performance, timely responses, safe operation, and ease of use during testing. Moreover, these findings indicate that the product effectively meets the required standards for user acceptability. The results show that the mean values of the indicators range from 4.05 to 4.38, which are numerically interpreted as "High" to "Very High." These results indicate that the respondents positively evaluated the wearable device in terms of its ability to detect electrical current exposure in real time. The overall mean of the table falls within the "High" interpretation, suggesting that the respondents generally perceive the wearable current sensing technology as accurate, reliable, and effective for electrical injury prevention. In addition, the standard deviation values range from 0.81 to 1.08, which are considered low, indicating that the responses are closely clustered around the mean.

Conclusion

Based on the findings of the study, it can be concluded that the wearable device was successfully designed and developed to detect current electrical exposure in real time. The device effectively met its intended purpose by providing timely detection and alerts, which are essential in reducing the risk of electrical hazards and improving user safety in simulated environments.

In addition, the assessment of the product's level of acceptability yielded positive results in terms of accuracy, responsiveness, safety, usability, and comfort. The device demonstrated reliable performance, was safe to use, easy to operate, and comfortable for users during testing. Overall, these results indicate that the wearable device is a practical and acceptable solution for monitoring electrical exposure, with potential for further improvement and real-world application.

Recommendations

For the development of the wearable current sensing technology, it is recommended that improvements be made to enhance the accuracy and sensitivity of the sensors used in detecting electrical current exposure. The developers may also improve the design of the device by using lighter and more durable materials to increase comfort and reliability. Enhancing battery life and alert mechanisms is likewise recommended to ensure continuous and effective operation.

For the evaluation of the device, it is recommended that future testing be conducted with a larger number of participants and in different simulated electrical environments. This would help provide more reliable data regarding the accuracy, responsiveness, safety, usability, and comfort of the device. Using standardized evaluation tools and collecting user feedback may further strengthen the validity of the results.

For students, it is recommended to increase awareness of electrical safety practices and recognize the importance of using protective technologies during laboratory activities and technical work. Understanding the function of wearable safety devices may help promote responsible and safe behavior.

For electricians, it is recommended to consider adopting wearable current sensing devices to enhance personal protection while working in electrically hazardous environments. Proper use of such devices may reduce the risk of electrical injuries and improve workplace safety standards.

For teachers, it is recommended to integrate discussions of wearable safety technologies into technical and vocational lessons. Emphasizing the value of preventive safety measures may help develop a strong safety culture among learners.

For school administrators, it is recommended to support the implementation and evaluation of innovative safety devices in workshops and laboratories. Providing resources and institutional backing may strengthen overall safety practices within the school.

For parents, it is recommended to encourage children to follow proper electrical safety practices at home and in school. Promoting awareness of protective technologies may help prevent avoidable electrical accidents.

For future researchers, it is recommended to further enhance the wearable current sensing technology by integrating advanced features such as wireless monitoring or mobile application support. Future studies may also focus on testing the device in real-life working environments to further validate its effectiveness and applicability.

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